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Utilization and Impact of Pre-Hospital Electrocardiograms for Patients With Acute ST-Segment Elevation Myocardial Infarction

Data From the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) Registry

Deborah B. Diercks, MD, MSc,* Michael C. Kontos, MD,† Anita Y. Chen, MS,‡ Charles V. Pollack, Jr, MD, MS,§ Stephen D. Wiviott, MD,‖ John S. Rumsfeld, MD, PhD,¶ David J. Magid, MD, MPH,¶ W. Brian Gibler, MD,# Christopher P. Cannon, MD,** Eric D. Peterson, MD, MPH,‡ Matthew T. Roe, MD, MHS,‡ on behalf of the NCDR ACTION Registry Participants

Sacramento, California; Richmond, Virginia; Durham, North Carolina; Philadelphia, Pennsylvania; Boston, Massachusetts; Denver, Colorado; and Cincinnati, Ohio

Objectives This study sought to determine the association of pre-hospital electrocardiograms (ECGs) and the timing of reperfusion therapy for patients with ST-segment elevation myocardial infarction (STEMI).

Background Pre-hospital ECGs have been recommended in the management of patients with chest pain transported by emergency medical services (EMS).

Methods We evaluated patients with STEMI from the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) registry who were transported by EMS from January 1, 2007, through December 31, 2007. Patients were stratified by the use of pre-hospital ECGs, and timing of reperfusion therapy was compared between the 2 groups.

Results A total of 7,098 of 12,097 patients (58.7%) utilized EMS, and 1,941 of these 7,098 EMS transport patients (27.4%) received a pre-hospital ECG. Among the EMS transport population, primary percutaneous coronary intervention was performed in 92.1% of patients with a pre-hospital ECG versus 86.3% with an in-hospital ECG, whereas fibrinolytic therapy was used in 4.6% versus 4.2% of patients. Median door-to-needle times for patients receiving fibrinolytic therapy (19 min vs. 29 min, $p = 0.003$) and median door-to-balloon times for patients undergoing primary percutaneous coronary intervention (61 min vs. 75 min, $p < 0.0001$) were significantly shorter for patients with a pre-hospital ECG. A suggestive trend for a lower risk of in-hospital mortality was observed with pre-hospital ECG use (adjusted odds ratio: 0.80, 95% confidence interval: 0.63 to 1.01).

Conclusions Only one-quarter of these patients transported by EMS receive a pre-hospital ECG. The use of a pre-hospital ECG was associated with a greater use of reperfusion therapy, faster reperfusion times, and a suggested trend for a lower risk of mortality. (J Am Coll Cardiol 2009;53:161–6) © 2009 by the American College of Cardiology Foundation

The American College of Cardiology/American Heart Association ST-segment elevation myocardial infarction (STEMI) guidelines recommend prompt reperfusion with fibrinolytic agents within 30 min of hospital arrival (door-to-needle time [DTN]) or primary percutaneous coronary intervention (PCI) within 90 min of arrival (door-to-balloon time [DTB]) (1). However, contemporary analyses show that the majority of hospitals in the U.S. do not meet these benchmarks for the

From the *University of California Davis Medical Center, Sacramento, California; †Virginia Commonwealth University Health System, Richmond, Virginia; ‡Duke Clinical Research Institute, Duke University Medical Center, Durham, North Carolina; §Pennsylvania Hospital, Philadelphia, Pennsylvania; ‖Brigham and Women's Hospital, Boston, Massachusetts; ¶University of Colorado Medical Center, Denver, Colorado; #University of Cincinnati Hospital, Cincinnati, Ohio; and the **TIMI Study Group, Brigham and Women's Hospital, Boston, Massachusetts.

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Abbreviations and Acronyms

CHF = congestive heart failure
DTB = door-to-balloon time
DTN = door-to-needle time
ECG = electrocardiogram
EMS = emergency medical services
IQR = interquartile range
PCI = percutaneous coronary intervention
STEMI = ST-segment elevation myocardial infarction

timing reperfusion therapy (2). A recent consensus statement endorsed the use of pre-hospital electrocardiograms (ECGs) to rapidly diagnose and triage patients transported by emergency medical services (EMS) with a suspected STEMI before hospital arrival (3). Regional or municipal studies performed within the last few years have shown that the use of pre-hospital ECGs was associated with shorter reperfusion times, and nationwide efforts have recently been developed to increase the availability of pre-hospital ECGs across the U.S. (4–7). We therefore analyzed data from the NCDR (National Cardiovascular Data Registry) ACTION (Acute Coronary Treatment and Intervention Outcomes Network) registry to evaluate the nationwide utilization and impact of pre-hospital ECGs in a large cohort of patients with STEMI.

Methods

The NCDR ACTION registry and quality improvement program began January 1, 2007. As applicable at each site, data collected for this registry were either approved by an institutional review board or considered quality assurance data, and not subject to institutional review board approval.

Patient inclusion criteria. Between January 1, 2007, and December 31, 2007, 271 ACTION hospitals enrolled 19,481 patients with STEMI (defined as persistent ST-segment elevation or new left bundle branch block and presenting within 24 h of ischemic symptom onset). We excluded the following patients: those not evaluated first in the emergency department or the cardiac catheterization laboratory (n = 2,575); patients transferred to an ACTION-participating hospital because the structure of the data collection form prevented delineation of location of the first ECG obtained (pre-hospital vs. in the outside hospital emergency department) (n = 4,568); those with missing information on EMS transport (n = 79); those with missing data on pre-hospital ECG (n = 69); and those not listed as being transported by EMS, but who had a pre-hospital ECG recorded (n = 93). The total initial analysis sample thus consisted of 12,097 patients with STEMI who directly presented to ACTION-participating hospitals either by self-transport or EMS transport.

Data collection and accuracy. Data were abstracted by a trained data collector at each hospital. Variables collected included pre-hospital data, medical history, treatments administered, as well as associated major contraindications to evidence-based therapies, and in-hospital outcomes.

Statistical analyses. Patients were initially categorized by whether or not they were transported by EMS. An in-depth comparison was made among those patients with and without a pre-hospital ECG, after restricting the analysis cohort to only those transported by EMS.

Demographic and clinical characteristics, reperfusion strategies, treatment patterns, and in-hospital outcomes were compared between patients with and without a pre-hospital ECG. Median values with interquartile ranges (IQRs) (25th, 75th percentile) were used to describe continuous variables, and numbers (percentages) were used for categorical variables. Patients were additionally classified regarding presenting during "on hours" (7 AM to 7 PM, Monday through Friday) or "off hours" (all other time periods), and by the time to the in-hospital ECG ≤10 or >10 min. To test for independence, pre-hospital ECG and baseline characteristics, in-hospital care patterns and outcomes, and the continuous and ordinal categorical variables were compared using stratum-adjusted Wilcoxon rank-sum tests, whereas nominal categorical variables were compared using stratum adjusted chi-square tests, for which stratification is by hospital.

We evaluated 2 process-of-care measures: time from door to reperfusion treatment with either fibrinolytic agents or primary PCI. In examining the association between pre-hospital ECG and time to reperfusion, we used the generalized estimating equations method to account for within-hospital clustering. Variables entered into the model are based on known clinical predictors of outcome. Furthermore, the relationship between in-hospital outcomes and pre-hospital ECG was explored using the logistic generalized estimating equations method adjusting for patient baseline characteristics only. Because DTB and DTN times were skewed, a log-transformation of these times was applied to normalize the distribution. When a dependent variable of a regression analysis has been transformed, the estimated coefficients must also be transformed to be interpreted appropriately (8). All analyses were performed using SAS software (version 9.1, SAS Institute, Cary, North Carolina).

Results

Clinical characteristics and treatment. A total of 7,098 of 12,097 patients (58.7%) included were transported to the ACTION-participating hospital by EMS. Patients transported by EMS were older; were less commonly male; more commonly had prior myocardial infarction (MI), prior congestive heart failure (CHF), and signs of CHF on presentation; and had shorter times from symptom onset to hospital presentation compared with patients who were self-transported to the ACTION-participating hospital (Table 1). Among the 7,098 patients transported by EMS, 1,941 (24.7%) received a pre-hospital ECG. Patients with a pre-hospital ECG were more commonly male, and less commonly had diabetes and left bundle branch block or signs of CHF on